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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte BERNHARD BUETTGEN, JONAS FELBER, MICHAEL LEHMANN, and THIERRY OGGIER

Appeal 2014-003584
Application 12/856,701
Technology Center 2800

Before ADRIENE LEPIANE HANLON, CATHERINE Q. TIMM, and JAMES C. HOUSEL, *Administrative Patent Judges*.

HOUSEL, *Administrative Patent Judge*.

DECISION ON APPEAL[1]

Pursuant to 35 U.S.C. § 134(a), Appellants[2] appeal from the Examiner's decision finally rejecting claims 1–17 as unpatentable under 35 U.S.C. § 103(a). We have jurisdiction over the appeal under 35 U.S.C. § 6(b).

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[1] Our decision refers to the Specification filed August 16, 2010, Appellants' Appeal Brief (Appeal Br.) filed September 30, 2013, the Examiner's Answer (Ans.) delivered November 27, 2013, and Appellants' Reply Brief (Reply Br.) filed January 27, 2014.

[2] According to Appellants, the real party in interest is MESA IMAGING AG. Appeal Br. 1.

We AFFIRM-IN-PART.

STATEMENT OF THE CASE

The invention relates to a demodulation pixel having a drift field incorporating one or more charge transport and photo-sensitivity enhancement mechanisms including 1) a buried channel, 2) a majority carrier current, 3) a high-low junction, and 4) a graded/gradually doped wafer structure. Spec. ¶ 18. Demodulation pixels have different fields of applications including three-dimensional range imaging and fluorescence lifetime imaging where higher in-pixel charge transport speed and optical sensitivity lead to more accurate per-pixel measurements. *Id.* at ¶ 2. "A common problem of . . . [prior] pixels is the slowness of the charge transport through the semiconductor material which decreases significantly the accuracy or quality of the in-pixel demodulation process." *Id.* at ¶ 7. Appellants disclose that the enhancement mechanisms outperform prior demodulation pixels in charge transport speed and photo-sensitivity. *Id.* at ¶ 18.

Independent claims 1 and 12, reproduced below from the Claims Appendix to the Appeal Brief, are illustrative of the subject matter on appeal (paragraphing added). The limitations at issue are italicized.

1. A demodulation pixel, comprising:
a semiconductor substrate;
a photo sensitive section in the semiconductor substrate for converting light into charge carriers;
storage nodes for receiving the charge carriers;
a demodulation region for transferring the charge carriers to the different storage nodes;
a majority carrier current through semiconductor substrate and under the photosensitive section that directs the

charge carriers to the demodulation region.

12. A demodulation pixel, comprising:

a semiconductor substrate;

a photo sensitive section in the semiconductor substrate for converting light into charge carriers;

storage nodes for receiving the charge carriers;

a demodulation region for transferring the charge carriers to the different storage nodes;

a high-low junction underneath the photo sensitive section for directing charge carriers generated in the photo sensitive section to a surface of the semiconductor substrate for transfer to the demodulation region.

Rejections

The following rejections under 35 U.S.C. § 103(a) are before us on appeal:

A. Claims 1–4 and 6–9 as unpatentable over Nakashima[3] and Schwarte;[4]

B. Claim 5 as unpatentable over Nakashima and Schwarte, further in view of Ichikawa;[5] and

C. Claims 10–17 as unpatentable over Nakashima and Schwarte, further in view of Sinha[6] and Yang.[7]

ANALYSIS

Rejection A

Appellants argue claims 1–4 and 9 separately. However, as will become clear within this decision, we need only address claim 1. The dispositive issue raised by Appellants' arguments against this rejection is whether the Examiner reversibly erred in finding that the Nakashima device as modified by Schwarte is inherently capable of forming a majority carrier current through the semiconductor substrate and under the photosensitive section. We answer this question in the affirmative and, therefore, will not sustain the Examiner's rejection.

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[3] Nakashima et al., US 2008/0048212 A1, published February 28, 2008 ("Nakashima").
[4] R. Schwarte, et al., "A new electrooptical mixing and correlating sensor: Facilities and Applications of the Photonic Mixer Device (PMD)," Proceedings of the SPIE – The International Society for Optical Engineering, Vol. 3100, pp. 245–253 (1997) ("Schwarte").
[5] Ichikawa et al., US 2009/0278174 A1, published November 12, 2009 ("Ichikawa").
[6] Amitabha Sinha, et al., "Effect of Heavy Doping on the Properties of High-Low Junction," IEEE Transactions on Electron Devices, Vol. ED 25, No. 12, pp. 1412–1414 (December 1978).
[7] Yang et al., US 6,184,055 B1, issued February 6, 2001 ("Yang").

The Examiner finds Nakashima teaches most aspects of the invention except for a majority carrier current flowing between two majority carrier nodes. Ans. 3–4. For this feature, the Examiner finds Schwarte teaches forming two majority, p+-type carrier nodes at either end of a photosensitive section so that the device can operate at high frequencies and low modulation voltages. *Id.* at 4. Therefore, the Examiner concludes it would have been obvious to form two majority, p+-type carrier nodes at either end of Nakashima's photosensitive section so that Nakashima's device can operate at high frequencies and low modulation voltages. *Id.*

In addition, the Examiner finds "the presence of a majority carrier current through semiconductor substrate and under the photo sensitive section is an inherent property of the device of Nakashima." *Id.* at 6. The Examiner finds these currents are known in the art as parasitic or leakage currents, are present even when the pixels are inactive, and can influence neighboring pixels. *Id.* As such, the Examiner finds Nakashima teaches isolation regions and Schwarte teaches p+ carrier node regions (channel stops). *Id.* The Examiner further finds Nakashima shows all the features of the claimed invention in support of the finding that the majority carrier current is an inherent property of Nakashima's device. *Id.* at 7. As such, the Examiner finds the inherent parasitic or leakage current in Nakashima's device is the majority carrier current. *Id.*

Appellants contend that Nakashima and Schwarte do not teach or suggest every feature of the claim 1. Appeal Br. 6. In particular, Appellants argue that Schwarte does not teach or suggest a majority carrier current through the semiconductor substrate and under the photosensitive section to direct charge carriers to a demodulation region. *Id.* Because Schwarte

teaches a combined photosensitive and demodulation region, Appellants argue that there is no need for a majority carrier that directs the charge carriers from a photosensitive section to a demodulation region. *Id.* at 6–7; Reply Br. 3. Appellants further argue that Schwarte does not teach two majority carrier nodes on either end of a photosensitive section between which the majority carrier current flows. Appeal Br. 7.

Moreover, Appellants urge that the Examiner's finding that Nakashima inherently has a majority carrier current is inconsistent with the Examiner's earlier finding that Nakashima fails to teach "a majority carrier current flowing between two majority carrier nodes." Reply Br. 1–2. Appellants also argue that it would not have been obvious to modify a device to have a component that creates an undesirable function. In other words, Appellants argue that it would not have been obvious to modify Nakashima's device, which the Examiner finds inherently has parasitic or leakage currents, with the nodes as Schwarte teaches to enhance such undesirable currents. *Id.* at 3.

Appellants' arguments are persuasive of reversible error in both the Examiner's inherency finding as well as the finding that the combination of Nakashima and Schwarte would provide a majority carrier current between two majority carrier nodes. We first turn to the Examiner's finding that Nakashima inherently provides a majority carrier current because of the inherent existence of parasitic or leakage currents and because Nakashima teaches all the physical features of the claimed invention. In general, a limitation is inherent "if it is the 'natural result flowing from' the explicit disclosure of the prior art." *Schering Corp. v. Geneva Pharms.*, 339 F.3d 1373, 1379 (Fed. Cir. 2003) (quoting *Eli Lilly & Co. v. Barr Labs., Inc.*, 251

F.3d 955, 970 (Fed. Cir. 2001)). "'Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing *may* result from a given set of circumstances is not sufficient.'" *In re Oelrich*, 666 F.2d 578, 581 (CCPA 1981) (quoting *Hansgirg v. Kemmer*, 102 F.2d 212, 214 (CCPA 1939)). What is required is that the inherent feature inevitably results from the disclosed steps. *In re Montgomery*, 677 F.3d 1375, 1380 (Fed. Cir. 2012).

The Examiner's support for the presence of parasitic or leakage current is the presence of isolation nodes 2 in Nakashima's Figure 2. Ans. 6. The Examiner finds such isolation nodes are present to control the effect of such undesirable currents. *Id.* However, what is not clear and is the subject of Appellants' challenge to the Examiner's inherency finding is whether such parasitic currents necessarily result in a majority carrier current through the semiconductor substrate and under the photosensitive section *to direct charge carriers to the demodulation region*. The Examiner does not direct our attention to any teaching that such parasitic currents direct charge carriers in any particular direction, much less under the photosensitive section to the demodulation region, nor do we find any.

As to the Examiner's finding that the combination of Nakashima and Schwarte provides a majority carrier current between two majority carrier nodes on either end of the photosensitive section between which the majority carrier current flows, we find Appellants' arguments persuasive that the combination would not provide a majority carrier current through the semiconductor substrate and under the photosensitive section that directs the charge carriers to a demodulation region. As Appellants assert (Appeal Br. 7), Schwarte's p+ nodes in Figure 2(b) are isolated from other components

(including a voltage source) via either a Si-oxide or Si_3N_4 insulation layer. Accordingly, Schwarte does not create a majority carrier current that directs charge carriers to a demodulation region. Moreover, Appellants assert without dispute that Schwarte teaches a combined photosensitive and demodulation region thereby negating any need for a majority carrier current.

Accordingly, we will not sustain the Examiner's obviousness rejection as to claims 1–4 and 6–9.

Rejection B

Claim 5 depends from claim 1, via claim 4, and further requires a funnel shaped depleted implantation region in the direction of the demodulation region. The Examiner does not rely on Ichikawa to remedy the above-discussed deficiencies in the combination of Nakashima and Schwarte. Accordingly, we will not sustain the Examiner's obviousness rejection of claim 5 for the same reasons as given above.

Rejection C

Appellants argue claims 10, 12, and 17 as a group, each of which recites a high-low junction under the photosensitive section for directing charge carriers to a surface of the semiconductor substrate. The Examiner does not rely on tertiary references to Sinha and Yang to remedy deficiencies in the combination of Nakashima and Schwarte as applied to claim 1. Thus, given the dependency of claims 10 and 11 on claim 1, we will not sustain the Examiner's obviousness rejection of claims 10 and 11

for the same reasons as given above. We, therefore, need only address claims 12 and 17.

The Examiner finds the combination of Nakashima and Schwarte fails to teach forming a high-low junction underneath the photosensitive section and wafer material having an interface with the semiconductor substrate forming the junction. Ans. 5. Nonetheless, the Examiner finds Sinha teaches providing a high-low junction underneath a photosensitive section to increase current and improve performance. *Id.* In addition, the Examiner finds Yang teaches forming a high-low junction between wafer material and a semiconductor substrate to improve sensor array modulation transfer function by reducing random diffusion of photoelectric charges. *Id.* Therefore, the Examiner concludes it would have been obvious to provide Nakashima's device with a high-low junction formed by a wafer material interface with the semiconductor substrate underneath the photosensitive section to increase current, reduce random diffusion of charges, and improve performance. *Id.* at 5–6.

Appellants argue that Sinha merely teaches a high-low junction at the back of a solar cell rather than a high-low junction underneath the photosensitive section for directing charge carriers to a surface of a semiconductor substrate for transfer to a demodulation region. Appeal Br. 9. Appellants further argue that Yang merely teaches reducing "miscollection" of photogenerated charges and does not teach a high-low junction underneath a photosensitive section to direct charge carriers generated in the photosensitive section to a surface of the semiconductor substrate for transfer to a demodulation region. *Id.* at 10. As such, Appellants contend the Examiner's proposed combination fails to teach or suggest a high-low

junction underneath the photo sensitive section for directing charge carriers generated in the photo sensitive section to a surface of the semiconductor substrate for transfer to the demodulation region. *Id.*

We do not find Appellants' arguments persuasive of reversible error in the Examiner's obviousness rejection of claims 12 and 17. Initially, we note that Appellants' arguments merely address each of Sinha and Yang individually, rather the combination as proposed by the Examiner. "Non-obviousness cannot be established by attacking references individually where the rejection is based upon the teachings of a combination of references. . . . [The reference] must be read, not in isolation, but for what it fairly teaches in combination with the prior art as a whole." *In re Merck & Co., Inc.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986). In this case, Appellants do not address the obviousness of providing a high-low junction underneath Nakashima's photosensitive section nor the Examiner's reasoning for doing so.

Further, while Appellants contend that the applied references fail to teach or suggest a high-low junction underneath the photosensitive section *for directing charge carriers generated in the photosensitive section to a surface of the semiconductor substrate for transfer to the demodulation region*, the Examiner finds without dispute that, given that the proposed combination provides the structure of the claimed device, the ability of the junction to direct charge carriers from the photo sensitive section to a surface of the substrate for transfer to the demodulation region is an inherent property of the combination device. Ans. 8. Appellants have not provided any persuasive reasoning or evidence establishing otherwise. Indeed, once a high-low junction is provided below the photosensitive

section for preventing drift or diffusion of charge carriers further into the substrate, it is reasonable to expect that these charge carriers will be directed away from the junction and toward a surface of the semiconductor substrate for transfer to the demodulation region.

Accordingly, we will sustain the Examiner's obviousness rejection of claims 12 and 17. Because Appellants do not separately argue claims 13–15, these claims fall with claim 12 from which they depend.

Appellants next argue that the Examiner has made no findings in support of the rejection of claim 16, which further requires a non-uniform doping profile in the photosensitive section for generating a lateral drift field to transfer charges to the demodulation region. Appeal Br. 10. We agree. We are unable to identify any particular Examiner finding in either the rejections or the response to arguments directed to claim 16 or a non-uniform doping profile. Nor are we able to find any teaching or suggestion in the Examiner's proposed combination for providing a non-uniform doping profile in the photosensitive section. We do not sustain the Examiner's obviousness rejection of claim 16.

CONCLUSION

The Section 103 rejections of claims 1–11 and 16 are not sustained, whereas the Section 103 rejection of claims 12–15 and 17 is sustained.

DECISION

Upon consideration of the record, the decision of the Examiner rejecting claims 1–4 and 6–9 under 35 U.S.C. § 103(a) as unpatentable over Nakashima and Schwarte is *reversed*;

rejecting claim 5 under 35 U.S.C. § 103(a) as unpatentable over Nakashima and Schwarte, further in view of Ichikawa is *reversed*; and

rejecting claims 10–17 under 35 U.S.C. § 103(a) as unpatentable over Nakashima and Schwarte, further in view of Sinha and Yang, is *reversed* as to claims 10, 11, and 16, and *affirmed* as to claims 12–15 and 17.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a)(1).

AFFIRMED-IN-PART